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The Total Solar Eclipse of August 17-18, 1868.

(Extract of a Letter from Major J. F. Tennant, R.E. to the Astronomer Royal.)

Guntoor, August 18, 1868.

"This morning was very promising, and if it had followed the course of its predecessor, we should have had a magnificent clear sky, but it clouded over the east with thin cumulostrati, which, while hardly stopping vision, interfere very much with the photographic energy; and the result was that every negative was under-exposed, and we have little more than very dense marks showing the protuberances. The six plates arranged for were duly exposed, but the heat so concentrated the nitrate-of-silver solution, that, besides showing but faint traces of any corona, they are all covered with spots. Still we may make something of them, and will try.

"Capt. Branfill reports the protuberances unpolarised, and the corona strongly polarised everywhere in a plane passing through the centre of the Sun.

"Complementarily I have to report a continuous spectrum from the corona, and one of bright lines from the prominence I examined. I am, I believe, safe in saying that three of the lines in the spectrum of the protuberances correspond to C, D, and *b*. I saw a line in the green near F, but I had lost so much time in finding the protuberance (owing to the finder having changed its adjustment since last night) that I lost it in the sunlight before measuring it, and I believe I saw traces of a line in the blue near G, but to see them clearly involves a very large change in the focus of the telescope, which was out of the question then.

"I conclude that my result is that the atmosphere of the Sun is mainly of non-luminous (or faintly luminous) gas at a short distance from the limb of the Sun. It may have had faintly

luminous lines, but I had to open the jaws a good deal to get what I could see at first, and, consequently, the lines would be diffused somewhat, still I think I should have seen them. The prominence I examined was a very high narrow one, almost to my eye like a bit of the Sun through a chink in brightness and colour (I could see no tinge of colour), and somewhat zigzagged like a flash of lightning. It must have been three minutes high, for it was on the preceding side of the Sun near the vertex, and was a marked object, both in the last photo-plate just before the Sun reappeared, and to the eye.

"Captain Branfill saw the prominences coloured, as did two other gentlemen, but one in my Observatory (like myself) only saw it white. I should, however, say that for long I never saw *α Orionis* markedly red, nor *Antares*, and I may not catch red soon, though I cannot conceive this being so.

"In conclusion, I may note that the darkness was very slight, and the colour not half so gloomy as in the eclipse of 1857, which was partial at Delhi, where I was then."

On the Cluster in Perseus. By Dr. O. Pihl.

I have the honour of laying before the Society the results of a micrometric examination of the Stellar Cluster in *Perseus*, commonly designated 65 *Bode* or 34 *Messier*, which I have been prosecuting since the year 1860, with a view to obtain, within comparatively small probable errors, a mensuration of all the more conspicuous stars, sufficiently exact to serve as a basis for investigating, at some remote date, the mechanism of the system.

The instrument employed is a Refractor, with $3\frac{1}{4}$ inch aperture, by H. Krog, of Bergen, equatorially mounted by Lohmeyer of Hamburg. Owing to the stars under examination, with three or four exceptions, being of a magnitude too low for the employment of a wire-micrometer with illuminated field, and the instrument not being provided with an arrangement for the illumination of the wires upon a dark field, I have been reduced to the exclusive use of bar-micrometers (Boguslawski's), with magnifying powers of 40 and 120, and to a ring-micrometer, with a magnifying power of 40; the latter, however, has been used to a less extent.

All the measurements have been referred to one particular star (No. 25 in the list) on the southern side of the group; the *absolute* position of which, as well as that of the secondary star (No. 33) on the northern side, required for using the Boguslawski micrometer, has been determined by recent observations by Argelander and Fearnley, as also by myself.

From these two fundamental stars a triangulation of the whole group has been performed, principally with the bar-micrometer, and in effecting this I have, for convenience, in addition to the

two above-named stars, employed nineteen others, partly for obtaining the Right Ascension and partly for the Declination. These stars have been examined with special care with reference to the two fundamental stars; and the probable error of their positions in that co-ordinate, for the determination of which for other stars they have been employed, does not generally amount to $0''.25$ of Great Circle.

A number of observations have been taken with the ring-micrometer, mostly with a specific object in view; for instance, the determination of very small differences in Declination. The total number of stars whose positions have been measured is 85; the probable errors in no case amount to $0''.5$ of arc of Great Circle in either co-ordinate; the mean probable error being in R.A. = $0''.298$, and in Decl. $0''.309$. The positions in R.A. and in Decl. have in the majority of cases been obtained by separate observations, the number of which, exclusive of those taken for obtaining the absolute positions, is as follows:—For R.A. 541 sets in all, or 65 on an average for each star; for Decl. 461 sets in all, or 55 on an average for each star; but of the latter observations, 418 have been taken with the bar-micrometer, and with that number of sets in either of the two opposite oblique positions of the bar. Each set consists, in the majority of cases, of from six to eight passages across the field.

So large a number of observations was necessary in order to ensure the accuracy required, more especially as the limited size of the instrument and the nature of the micrometers employed are not favourable for obtaining exact results with but few observations.

Having no Meridian Circle at my disposal, I have had to adopt a circuitous and somewhat laborious method for determining the absolute position of the group, and for that purpose resorted to γ *Andromedæ*, the position and proper motion of which have been closely determined by several of the most distinguished of modern astronomers;* this star, at a distance of about 38^m preceding the centre of the group, having a Declination of about $30'$ of arc south of two of the larger stars in the system.

By means of the ring-micrometer (with a mean radius of $1023''.79$) the Declination of these two stars, with reference to γ *Andromedæ*, was found by eleven passages of each. The Right Ascension of three other stars, more favourably situated for that purpose than the two above-named, was determined, on an average, by eight passages of each.

However, being sensible of the numerous chances of error in this mode of determining the position with comparative exactness, I applied to my friend, Professor Fearnley, Director of the Royal Observatory, Christiania, who, by means of the Meridian Circle, kindly obtained the positions of two of the northern, and two of

* Mädler: "Der Fixsternhimmel," p. 23.

the southern, stars, including the two fundamental stars (Nos. 25 and 33), referred to above.

Having noticed in the *Astronomische Beobachtungen* of the Bonn Observatory, that three of the northern stars in the group had been measured by the Meridian Circle of that establishment, among which were the two observed by Professor Fearnley, I wrote to Professor Argelander, who most obligingly furnished me with his positions, as also with the Right Ascension of two other stars. On my own measurements of Right Ascension of the above three stars, by means of γ *Andromedæ*, whose position had been determined with a probable error of $0^s.023$, I felt safe in placing a considerable degree of reliance; and as Argelander's and Fearnley's positions, in that co-ordinate, of one of the two stars obtained by both, did not agree very well, whereas my positions, both for this star and for the second measured by those astronomers, — and with regard to which they agree closely, — was not far from the mean of their results ($0^s.094$ and $0^s.058$ respectively), I have felt justified in using my own results, as well as those of Argelander and Fearnley, for finally determining the absolute Right Ascension.

But in finding the absolute Declination, I have totally rejected my own results, determined by γ *Andromedæ*, which, however, within $2''$ agree with the mean of Argelander and Fearnley's positions: for in this co-ordinate two causes of error are present which cannot be eliminated, viz., the error arising from the error in value of the dimensions of the ring of the micrometer, and the error to be anticipated from the vast difference between the intensity of light in γ *Andromedæ* and of the stars compared with it, — an error which, with so large a difference in Declination, could not be neutralised by measuring the pairs of stars in the upper and lower part of the ring alternately.

By combining Argelander's and Fearnley's results with my own, the ultimate value obtained in Right Ascension varies in four stars from $+0^s.219$ to $+0^s.328$, and in one (No. 33) the difference is $-0^s.011$ from those of Argelander's. It may, however, be observed, that the first four of these stars have been observed by Argelander only on one evening, and upon only one to three wires, whereas the last has been observed on two occasions, and, on one of these, upon seven wires. On the other hand, the above ultimate value varies from $-0^s.105$ to $-0^s.247$ from Fearnley's Right Ascensions.

By combining the positions in Declination of the four stars measured by Fearnley, and of the two by Argelander, with my own *relative* positions of these stars, the resulting values vary from $+0''.50$ to $-1''.30$ from Fearnley's, and are $+0''.08$ and $2''.28$, respectively, at variance with Argelander's positions; the former difference being for the star No. 33, observed by Argelander with the four microscopes, whereas the latter was observed with only one.

The main object of my investigation being to determine the

relative positions of the individual stars, they have all, as previously observed, been referred to a single star (No. 25) in the southern part of the group.

In the following Catalogue the positions with respect to that star are, therefore, given,—in R.A. in seconds of time, and in Decl. in seconds of arc,—but separate columns also contain the absolute positions.

The Probable Error of each position is specified: with regard to R.A. this error is expressed in time, and in an adjacent column reduced to arcs of Great Circle.

In the calculation of the Probable Errors, due reference has been paid to the relative value of each observation entering into the calculation; the formula employed being

$$\text{P. E.} = 0.67449 \sqrt{\frac{n \sum \Delta^2}{(n-1) \left(\frac{1}{p_1} + \frac{1}{p_1} \dots \frac{1}{p_n} \right) (p_1 + p_2 \dots p_n)}}$$

or, for sets with each observation of equal value, the reduced form,

$$\text{P. E.} = 0.67449 \sqrt{\frac{\sum \Delta^2}{n(n-1)}}$$

n denoting the number of observations, and $p_1 p_2 \dots p_n$ the relative values of the separate observations entering into the calculation.

The constants employed for the calculation of Precession are those of Bessel.

With regard to the magnitude of the stars, I have endeavoured to express them according to Argelander's standard.

The Positions of Bessel in the last column of the Table are reduced from those given in the *Königsberger Beobachtungen*, vol. xvii.: for Zone 529, the corrections given in Cat. II. by Weisse, have been taken into account. It will be observed, that these positions, and specially the positions *inter se* of these seven stars of Bessel's, are, within amounts not altogether slight, at variance with those I have found to exist at the present time. I am aware that it would be premature to conclude from these differences any proper motions of the stars; but, at the same time, the differences are, no doubt, large enough to deserve special notice. In Declination, for instance, Bessel's position for No. 12 differs $-9''.67$ from mine; for No. 25 $-2''.01$; for No. 60 $+2''.41$; for No. 82 $-7''.04$, &c. Bessel's difference in Declination between No. 12 and No. 60 is, therefore, upwards of $12''$, and between No. 60 and No. 82, about $9''.5$ at variance with mine,—differences which appear somewhat suspicious. They are, undoubtedly, very large, if supposed to arise merely from errors in observation,—considering that Bessel's mean Probable Errors in Declination in his Zone Observations are, so far as I am aware, only about $1''.5$, and that the mean Probable Error in my ob-

servations of these stars is only $0''\cdot21$. It might be inferred that, as Bessel's Declinations are, in all cases but one,—namely, in that of No. 60, more southerly than those obtained by means of Argelander and Fearnley's Meridian Observations,—the exception, as regards No. 60, may be owing to an error in the reading off of the Declination of that star,—a supposition which the Declination given by Lalande would seem to corroborate. But, on the other hand, it may be remarked that Bessel has measured Nos. 25 and 60 on the same evening, and, consequently, the one immediately after the other, and that yet he has placed No. 60 $3''\cdot30$ north of No. 25; while now it is, according to my measurement, $0''\cdot93$, and, according to Fearnley, even $2''\cdot75$ south of it. Now, if the probable error of a single star in Bessel's Zone Observations is in Decl. = $1''\cdot5$, the mean probable error of the above seven stars would be $0''\cdot6$. But the mean Declination of Bessel's seven stars is $4''\cdot27$ south of the mean Declination now determined. Is it probable that this difference is owing merely to errors in observation, or to errors in the constants, notwithstanding Weisse's revision of Bessel's Tables of Reduction, and to no physical change? Of course this cannot now be answered; but I trust that the examination, the results of which are contained in the preceding Catalogue, may, on some future investigation, be the means of successfully solving the problem, as regards the mutual proper motions of the stars in this extensive system.

On the Plate representing the group, I have, in addition to the stars measured, marked all other stars (117 in number), which, under the most favourable circumstances, can be seen or sighted in my instrument. Their positions have no claim to accuracy beyond that of careful sketches. The 85 stars numbered on the plate have alone been measured and laid down accordingly.

Tullubjerget, Christiania, June 26, 1868.

No.	Mag.	No. of Obs.	Right Ascension.		Prob. Error.		Yearly Precession.		Declination.	
			Mean R.A. 1865°.	R.A. refer. to No. 25.	Secs. of Time.	Secs. of Gt. Circ.	1865°.	Secul. Change.	No. of Obs.	Mean Decl. 1865°.
1	10.4	7	2 31 50 ^{h m s} 286	—62 682	0 041	0 46	3 8172	+0 0396	4	42 13 26 ^{o ' ' "} 20
2	9.9	6	56 069	56 899	0 39	43	8181	0 396	4	42 14 36 90
3	10.4	4	59 086	53 882	0 27	30	8192	0 396	6	42 16 35 70
4	10.1	4	32 10 725	42 243	0 18	20	8162	0 397	4	42 7 59 28
5	9.8	4	11 886	41 082	0 24	27	8222	0 398	4	42 21 36 72
6	10.7	5	13 974	38 994	0 26	29	8158	0 395	4	42 6 39 84
7	8.8	8	19 383	33 585	0 20	23	8209	0 397	6	42 17 21 12
8	10.3	4	19 813	33 155	0 22	25	8196	0 396	4	42 14 23 34
9	8.7	9	22 844	30 124	0 20	23	8221	0 398	5	42 19 25 98
10	9.7	4	24 871	28 097	0 15	17	8241	0 399	5	42 23 46 18
11	10.0	5	27 534	25 434	0 39	43	8161	0 394	4	42 5 5 09

No.	Mag.	No. of Obs.	Right Ascension.		Prob. Secs. of Time.	Error. Secs. of Gt. Circ.	Yearly Precession.		Declination.	
			Mean R. A. 1865°.	R. A. refer. to No. 25.			1865°	Secul. Change.	No. of Obs.	Mean Decl. 1865°.
12	8.7	18	^h 2 ^m 32 ^s	— 20° 845	^s 0° 014	° 016	3° 8168	+ 0° 0394	7	42° 5' 46" 83
13	10.7	4	34° 017	18° 951	° 018	° 20	° 8252	° 0399	4	42° 24' 47" 47
14	10.7	6	34° 329	18° 639	° 043	° 48	° 8248	° 0399	4	42° 23' 52" 69
15	10.5	4	37° 448	15° 520	° 020	° 23	° 8251	° 0399	7	42° 23' 59" 74
16	9.5	6	38° 312	14° 656	° 032	° 36	° 8184	° 0395	6	42° 8' 38" 24
17	10.7	4	40° 601	12° 367	° 019	° 22	° 8258	° 0399	6	42° 25' 4" 02
18	9.3	7	41° 075	11° 893	° 021	° 24	° 8226	° 0397	5	42° 17' 47" 81
19	10.5	4	41° 392	11° 576	° 018	° 21	° 8211	° 0396	4	42° 14' 13" 07
20	10.7	5	43° 664	9° 304	° 041	° 46	° 8254	° 0398	4	42° 23' 43" 36
21	10.4	4	44° 106	8° 862	° 023	° 26	° 8141	° 0392	5	41° 57' 37" 58
22	9.4	4	44° 486	8° 482	° 016	° 18	° 8213	° 0396	4	42° 14' 12" 17
23	9.4	4	45° 978	6° 990	° 022	° 25	° 8220	° 0396	4	42° 15' 41" 94
24	9.9	8	50° 211	2° 757	° 034	° 38	° 8149	° 0392	4	41° 58' 45" 01
25	8.0	...	52° 968	0° 000	...	...	° 8160	° 0393	...	42° 0' 45" 47
26	9.3	4	59° 345	+ 6° 377	° 027	° 30	° 8273	° 0399	4	42° 25' 28" 01
27	9.4	6	59° 695	6° 727	° 021	° 24	° 8240	° 0397	7	42° 17' 55" 06
28	10.0	5	33 0° 820	7° 852	° 042	° 47	° 8195	° 0395	5	42° 7' 29" 99
29	9.6	4	1° 897	8° 929	° 017	° 19	° 8213	° 0396	5	42° 11' 29" 00
30	10.2	7	7° 743	14° 775	° 033	° 37	° 8201	° 0395	5	42° 8' 6" 28
31	8.3	18	8° 780	15° 812	° 015	° 17	° 8218	° 0396	10	42° 11' 26" 20
32	10.6	4	10° 974	18° 006	° 029	° 33	° 8243	° 0397	5	42° 16' 48" 47
33	7.8	...	14° 345	21° 377	...	...	° 8284	° 0399	...	42° 25' 36" 01
34	10.1	5	15° 326	22° 358	° 022	° 25	° 8196	° 0394	5	42° 5' 33" 85
35	8.0	4	16° 896	23° 928	° 013	° 15	° 8229	° 0396	8	42° 12' 35" 76
36	8.0	20	18° 637	25° 669	° 015	° 17	° 8230	° 0396	5	42° 12' 43" 60
37	10.2	5	19° 779	26° 811	° 038	° 42	° 8195	° 0394	4	42° 4' 29" 36
38	8.9	6	22° 090	29° 122	° 030	° 33	° 8221	° 0395	5	42° 10' 7" 27
39	10.4	5	23° 773	30° 805	° 031	° 34	° 8161	° 0392	4	41° 56' 8" 23
40	9.2	11	25° 007	32° 039	° 029	° 32	° 8171	° 0392	9	41° 58' 0" 42
41	7.7	10	26° 080	33° 112	° 013	° 15	° 8213	° 0395	13	42° 7' 39" 70
42	9.8	4	26° 755	33° 787	° 032	° 35	° 8229	° 0395	5	42° 11' 10" 52
43	8.8	6	30° 434	37° 466	° 023	° 26	° 8249	° 0396	8	42° 15' 11" 04
44	10.3	5	30° 660	37° 692	° 035	° 39	° 8228	° 0395	4	42° 10' 25" 06
45	9.3	9	32° 355	39° 387	° 028	° 31	° 8238	° 0396	4	42° 12' 26" 87
46	8.7	6	33° 330	40° 362	° 030	° 33	° 8228	° 0395	7	42° 10' 2" 33
47	7.7	12	33° 487	40° 519	° 012	° 14	° 8216	° 0395	12	42° 7' 11" 67
48	8.3	7	33° 590	40° 622	° 025	° 28	° 8237	° 0396	5	42° 11' 55" 33
49	10.2	5	33° 809	40° 841	° 024	° 27	° 8196	° 0393	4	42° 2' 30" 64
50	8.6	4	34° 085	41° 117	° 028	° 31	° 8260	° 0397	6	42° 17' 12" 91
51	9.3	7	34° 181	41° 213	° 037	° 41	° 8264	° 0397	7	42° 17' 4" 96
52	10.3	5	36° 532	43° 564	° 043	° 48	° 8266	° 0397	4	42° 18' 1" 07
53	10.4	6	37° 863	44° 895	° 031	° 34	° 8193	° 0393	4	42° 1' 19" 71

No.	Mag.	No. of Obs.	Right Ascension.			Prob. Error.			Yearly Precession.			Declination.		
			Mean R. A. 1865°	R. A. refer. to No. 25.		Secs. of Time.	Secs. of Gt. Circ.		1865°	Secul. Change.	No. of Obs.	Mean Decl. 1865°.		
54	8.3	6	^h 2 ^m 33 ^s 42'24.8	-49'28.0		0'02.8	0'31	^s 3'82.37	+0'03.95		7	42° 10' 51".93		
55	10.2	5	43'56.4	50'59.6		0'38	42	8'19.7	0'39.3		4	42° 1' 16".17		
56	8.4	9	47'27.2	54'30.4		0'19	22	8'24.1	0'39.5		6	42° 10' 45".66		
57	10.2	6	50'39.7	57'42.9		0'21	24	8'20.2	0'39.3		5	42° 1' 19".84		
58	9.3	5	50'57.6	57'60.8		0'25	28	8'30.0	0'39.8		4	42° 23' 35".67		
59	10.3	7	54'88.7	61'9.19		0'37	41	8'24.4	0'39.5		4	42° 10' 04".		
60	7.2	11	55'65.9	62'69.1		0'20	23	8'20.3	0'39.3		18	42° 0' 44".55		
61	9.4	4	56'03.1	63'06.3		0'23	26	8'28.8	0'39.7		4	42° 20' 5".37		
62	10.2	5	58'9.12	65'9.44		0'32	35	8'26.8	0'39.6		4	42° 15' 5".63		
63	10.4	6	34 4'4.15	71'44.7		0'37	41	8'27.0	0'39.6		8	42° 14' 46".39		
64	7.9	12	5'36.2	72'39.4		0'19	22	8'27.0	0'39.6		8	42° 14' 31".39		
65	10.1	5	5'6.43	72'6.75		0'30	33	8'23.9	0'39.4		6	42° 7' 16".80		
66	9.9	6	8'0.12	75'0.44		0'27	30	8'23.5	0'39.4		5	42° 6' 6".00		
67	10.2	6	11'32.8	78'36.0		0'24	27	8'21.1	0'39.3		5	42° 0' 11".09		
68	10.3	6	11'54.7	78'57.9		0'35	39	8'24.9	0'39.5		4	42° 8' 47".03		
69	9.5	5	12'38.1	79'4.13		0'32	35	8'22.0	0'39.3		4	42° 2' 3".63		
70	10.6	4	13'59.2	80'6.24		0'11	13	8'20.8	0'39.3		6	41° 59' 10".01		
71	10.0	7	15'76.1	82'7.93		0'35	39	8'27.7	0'39.6		5	42° 14' 27".08		
72	9.9	4	18'9.16	85'9.48		0'16	18	8'29.9	0'39.7		4	42° 19' 2".93		
73	8.3	20	20'08.9	87'12.1		0'15	17	8'33.1	0'39.9		12	42° 26' 0".83		
74	10.6	7	30'6.46	97'6.78		0'31	34	8'22.2	0'39.3		5	41° 59' 50".82		
75	10.6	7	33'38.7	100'4.19		0'29	32	8'23.3	0'39.3		5	42° 0' 40".55		
76	9.8	4	34'47.8	101'5.10		0'10	12	8'32.6	0'39.8		6	42° 22' 29".63		
77	9.8	4	36'24.2	103'2.74		0'32	35	8'29.9	0'39.6		4	42° 16' 16".67		
78	9.6	5	38'46.6	105'4.98		0'38	42	8'28.5	0'39.5		4	42° 12' 46".40		
79	10.4	6	38'82.3	105'8.55		0'30	33	8'26.8	0'39.4		4	42° 8' 52".13		
80	8.7	7	45'07.1	112'10.3		0'23	26	8'28.5	0'39.5		6	42° 11' 46".00		
81	10.0	5	50'1.47	117'1.79		0'36	40	8'29.5	0'39.5		5	42° 13' 8".90		
82	8.4	12	52'25.6	119'2.88		0'25	28	8'25.0	0'39.3		9	42° 2' 40".22		
83	10.0	7	35 1'0.11	128'0.43		0'36	40	8'29.5	0'39.5		4	42° 11' 29".25		
84	10.7	4	5'83.6	132'86.8		0'27	30	8'30.0	0'39.5		4	42° 11' 58".55		
85	10.3	6	2 35 19'0.26	-146'05.8		0'03.9	0'43	3'83.14	+0'03.95		4	42° 12' 48".52		

No.	Decl. refer. to No. 25.	Yearly Precession.		Positions found by other Observers reduced to 1865°.		
		Prob. Error.	1865°.	Secul. Change.	Mean R. A.	Mean Decl.
1	+ 760".73	0'24	15'8.11	-0'35.0	^h ^m ^s	" ' "
2	+ 831'43	31	8'06	350		
3	+ 950'29	46	8'03	350		
4	+ 433'81	44	7'93	351		
5	+ 1251'25	21	7'92	351		
6	+ 354'37	41	7'90	351		

No.	Decl. refer. to No 25.	Prob. Error.	Yearly Precession.		Positions found by other Observers reduced to 1865.0.		
			1865.0	Secul. Change.	Mean R.A.	Mean Decl.	
7	+ 995.65	0.13	15.785	-0.351	^h 2 ^m 32 ^s 19.109	" .. "	Argelander 1860.9
8	+ 817.87	.34	.784	.351			
9	+ 1120.51	.21	.782	.351	2 32 22.571	42 19 23.70	Argelander 1860.9
10	+ 1380.71	.42	.779	.351			
11	+ 259.62	.17	.777	.351			
12	+ 301.36	.30	.774	.351	2 32 32.076	42 5 37.16	Bessel 1831.9
13	+ 1442.00	.39	.772	.351			
14	+ 1387.22	.09	.771	.352			
15	+ 1394.27	.42	.769	.352			
16	+ 472.77	.36	.767	.352			
17	+ 1458.55	.41	.766	.352			
18	+ 1022.34	.24	.765	.352	2 32 40.856	...	Argelander 1860.9
19	+ 807.60	.26	.765	.352			
20	+ 1377.89	.43	.763	.352			
21	- 187.89	.48	.762	.352			
22	+ 806.70	.29	.762	.352			
23	+ 896.47	.22	.761	.352			
24	- 120.46	.35	.757	.352			
25	0.00	...	.754	.352	2 32 53.044	42 0 43.46	Bessel 1831.9
26	+ 1482.54	.39	.749	.352	2 32 53.215	42 0 46.77	Fearnley 1865.1
27	+ 1029.59	.36	.748	.352			
28	+ 404.52	.22	.747	.352			
29	+ 643.53	.34	.746	.352			
30	+ 440.81	.33	.741	.353			
31	+ 640.73	.23	.740	.353			
32	+ 963.00	.31	.738	.353			
33	+ 1490.54	...	.735	.353	2 33 14.356	42 25 35.93	Arg. 1860.9 & 1861.1
34	+ 288.38	.30	.734	.353	2 33 14.450	42 25 36.40	Fearnley 1865.1
35	+ 710.29	.28	.732	.353	2 33 17.070	42 12 30.98	Bessel 1831.9
36	+ 718.13	.32	.731	.353	2 33 18.358	42 12 38.44	Bessel 1831.9
37	+ 223.89	.20	.729	.353			
38	+ 561.80	.28	.728	.353			
39	- 277.24	.40	.727	.353			
40	- 165.05	.17	.725	.353			
41	+ 414.23	.18	.724	.353	2 33 26.236	42 7 36.10	Bessel 1831.9
42	+ 625.05	.34	.724	.353			
43	+ 865.57	.28	.721	.353			
44	+ 579.59	.45	.720	.354			
45	+ 701.40	.29	.719	.354			
46	+ 556.86	.31	.718	.354			
47	+ 386.20	.17	.718	.354			
48	+ 669.86	.21	.718	.354			

No.	Decl. refer. to No. 25.	Yearly Precession.		Positions found by other Observers reduced to 1865°.		
		Prob. Error.	1865°.	Secul. Change.	Mean R.A.	Mean Decl.
	"	"	"	"	h m s	" ' "
49	+ 105°17	0°18	15°717	-0°354		
50	+ 98°44	'40	'717	'354		
51	+ 103°49	'38	'717	'354		
52	+ 103°56	'41	'715	'354		
53	+ 34°24	'41	'714	'354		
54	+ 60°46	'34	'711	'354		
55	+ 30°70	'45	'708	'354		
56	+ 600°19	'24	'705	'354		
57	+ 34°37	'20	'703	'354		
58	+ 137°20	'19	'702	'354		
59	+ 562°57	'35	'698	'354	2 33 55°136	42 0 43°89 Lalande 1790?
60	- 0°92	'10	'698	'354	2 33 56°066	42 0 46°96 Bessel 1831°9
61	+ 115°90	'18	'697	'354	2 33 55°860	42 0 44°05 Fearnley 1865°1
62	+ 86°16	'44	'695	'355		
63	+ 84°92	'40	'690	'355		
64	+ 82°92	'20	'689	'355	2 34 3°600	42 14 29°69 Lalande 1790?
65	+ 391°33	'47	'688	'355		
66	+ 320°53	'30	'687	'355		
67	- 34°38	'27	'683	'355		
68	+ 481°56	'37	'683	'355		
69	+ 78°16	'21	'683	'355		
70	- 95°46	'47	'681	'355		
71	+ 821°61	'26	'679	'355		
72	+ 1097°46	'38	'677	'356		
73	+ 1515°36	'16	'675	'356	2 34 19°761	(42 25 57°43) Argelander 1861°1
74	- 54°65	'43	'666	'356	2 34 20°230	42 26 1°20 Fearnley 1865°1
75	+ 55°08	'41	'663	'356		
76	+ 1204°16	'46	'662	'356		
77	+ 931°20	'19	'661	'356		
78	+ 720°93	'15	'659	'356		
79	+ 486°66	'45	'658	'356		
80	+ 660°53	'29	'653	'356		
81	+ 743°43	'20	'648	'357		
82	+ 114°75	'24	'646	'357	2 34 52°444	42 2 33°18 Bessel 1831°9
83	+ 643°78	'45	'638	'357		
84	+ 673°08	'42	'634	'357		
85	+ 723°05	0°27	15°622	-0°358		

*A Rediscussion of the Observations of the Transit of
Venus, 1769.* By E. J. Stone, Esq.

Several methods of great refinement have been applied, within the last few years, to the determination of the fundamental unit of length of the Solar System,—the mean distance of the Sun from the Earth, or its equivalent, the mean horizontal equatorial parallax of the Sun. These investigations have all pointed to values about $8''.90$. Each method appears to have its own inherent difficulty, but it is inconceivable that the systematic errors of each of these methods should tend to unduly increase the resulting value of the solar parallax. In opposition to the value $8''.90$ we have that of $8''.58$ deduced by Encke from the transits of *Venus* of 1761 and 1769. A transit of *Venus* has been considered, and I think justly considered, the most favourable of all our opportunities for the accurate determination of the solar parallax.

The observations made in 1769 were made, under generally favourable circumstances, by observers of experience. The places of observation were undoubtedly chosen with skill and judgment. The results have been discussed by an astronomer of acknowledged skill and ability. The discordance of the value thus deduced, by more than $0''.3$ from the mean of the values determined, by at least three other independent methods, each entitled to great confidence, has naturally given rise to much anxiety and some doubt. It appeared to me that a new discussion of the observations made in 1769 must necessarily lead, if to nothing else, to a clearer view of the sources of systematic error, or wrong interpretation, which might be feared, and ought to be guarded against, in the observations proposed to be made at the Transits of 1874 and 1882.

I believe that my investigation has led me to the detection of several grave and fundamental errors, which have previously been made in the discussion of these results, and to a value of the solar parallax entitled to be received with confidence. From P. Hell's *Reise nach Wardoe bei Lappland und seine Beobachtung des Venus-Durchganges im Jahre 1769*, by Carl Ludwig Littrow. Wien, 1835, I extract the following:

Ingress.

“Internus autem limborum Solis et Veneris contactus Sole sat clare lucente, attamen aliquantulum limbo Solis et Veneris undulantibus observatus a me Tubo Dolondiano Haffniensi.

	H	M	S
Videtur contactus fieri	9	32	35
Contactus certus Visus		32	41
Fulnien		32	48

Pater Sajnovics suo tubo

Contactus dubius	9	32	30	30
Certissimus ut ajebat	9	32	45	45

Idem obtinuit D. Borgrewing secunda nempe — 10"—post numerata minuta, sed loco 32 minutorum mihi exhibuit 33'.

Egress.

Ego tubo meo ad idem Horologium

				H	M	S
Videtur aliqua gutta nigra intra limbum Solis						
et Veneris ante contactum formari	..			15	26	6
gutta hæc minui videtur valde	..				26	12
Disparet, et contactum fieri censeo	..				26	17
Certissimus contactus	..	..	..		26	19

Pater Sajnovics.

Contactus dubius certus	..	..	..	15	26	18
Certus	..	..	..			26
D. Borgrewing	..	..	..	15	26	10

Some alterations and additions to the Journal made in darker ink, are indicated by bolder writing. They appear to be chiefly in the order of arrangement and explanation. Fulmen 32 48, appears alone in the darker ink.

It will be seen that at the egress Father Hell makes a distinction between the forming of the black drop and the contact. It has been previously assumed that at the ingress "contactus certus visus," refers to the breaking of the black drop, although we have the phrase, "Disparet, et contactum fieri censeo," &c., referring to the actual contact of the limbs at the egress. This false interpretation is at the very root of the discussion, and an error here leads to nothing but confusion. I shall assume, and I think there will be no further doubt upon this point, that the same phrases must be similarly interpreted at the ingress and egress. Therefore, taking the means of "dubius certus" and "certus" as the true time of contact, I have

Ingress.

	Contact of Limbs.	Reduction to true M.T.
	^h ^m ^s	^m ^s
Hell's observation	9 32 38	— 1 1'8
Sajnovics'	9 32 37.5	— 1 1'8

Hence, in Paris Mean Time, we have,

	^h ^m ^s
Hell's observations	9 31 36.2
Sajnovics'	9 31 35.7

I believe it probable that the minutes given by Borgrewing are right, and that he really tried to observe the breaking of the black drop. This, however, is doubtful, and I shall not use the observation.

Egress.

	Contact of Limbs.	Correction to M.T.
	^h ^m ^s	^s
Hell's observation	15 26 18.0	— 59.6
Sajnovics'	15 26 22.0	— 59.6
D. Borgrewing	15 26 10	

Or, in Paris Mean Time,

	^h ^m ^s
Hell's observation	15 25 18.4
Sajnovics'	15 25 22.4

Since Borgrewing's corresponding observation at ingress is lost, I shall not use his observation at egress. Its use would not, however, change my result. I adopt, therefore, the following observed durations from internal contact to internal contact at Wardhus:—

	^h ^m ^s
From Hell's observations	5 53 42.2
From Sajnovics'	5 53 46.7

I would also call attention to Father Hell's difference at egress between the formation of the black drop and contact of the limbs, viz. 12^s.

Kola.

The observations at this station were made under unfavourable circumstances. I shall adopt the same data as Encke. The phase is that from the breaking to the formation of the black drop. Encke places the observations in the second class. I shall give it a weight one-half that of the other observations. It is, however, very exactly represented by my result.

Observations at Hudson's Bay by W. Wales and Dymond. Extracted from the *Phil. Trans.* 1769.

	Apparent Time.	
	^h ^m ^s	
Exterior contact at the ingress	0 57 0.6	J.D.
	0 57 7.6	W.W.
Interior ditto	1 15 21.3	W.W.
	1 15 25.3	J.D.
The thread of light broke at the	7 0 45.5	W.W.
internal contact	7 0 48.5	J.D.
External contact	7 19 1.25 } 7 19 20.25 }*	W.W. J.D.

* Very hazy, and the limbs badly defined.

Remarks.

(3) The heavens at the beginning, and for a considerable time, both before and after, were frequently obscured by clouds, but, in the intervals, the air was very clear, and the Sun's limbs extremely well defined.

(4) Soon after *Venus* was half immersed, a bright crescent, or rim of light, encompassed all that part of her circumference which was off the Sun, thereby rendering her whole periphery visible. This continued very bright until within a few minutes of the internal contact, and then vanished away gradually.

(5) We took for the instant of the first internal contact the time when the least visible thread of light appeared behind the subsequent limb of *Venus*, but before that time *Venus'* limb seemed within that of the Sun, and his limb appeared behind hers in two very oblique points, seeming as if they would run together in a broad stream, like two drops of oil, but which, nevertheless, did not happen, but joined in a very fine thread, at some distance from the exterior limb of *Venus*. This appearance was much more considerable at the egress than at the ingress, owing, as we apprehend, to the bad state of the air at the time. We took for the instant of internal contact, at the egress, the time when the thread of light disappeared before the preceding limb of the planet, from which time W.W. took notice that he had told about 24^s when the limbs of the Sun and *Venus* were apparently in contact; a circumstance which he did not venture to attend to at the egress.

(6) Nothing like an atmosphere (except the above-mentioned phenomena); no satellite observed.

(7) The haziness at egress arose from the usual state of the atmosphere, 10° or 12° above the horizon.

The observations of Wales and Dymond refer to the time of the breaking and formation of the black drop. Wales estimates the interval between the forming of the black drop at egress and the contact of the limbs at 24^s . These observations are clearly not comparable with those made at Wardhus, except allowance be made for the difference of phase observed.

St. Joseph.

The observers at and near this station were Chappe, Pauly, Vicente Doz, and Salvador Medina. I cannot find any details of the observations of Vicente Doz and Salvador Medina, but their results agree so closely with those of Chappe that the observations evidently refer to the same phases of the phenomena.

Extract from "*Voyage en Californie pour l'Observation du Passage de Vénus sur le disque du Soleil, le 3 Juin, 1769.*" Par M. Chappe." Paris, 1772.

	Temps observé à la pendule.	Temps Vrai.
	^h ['] ["]	^h ['] ["] ^{'''}
2 Juin	23 57 32	23 59 17 2

à la lunette achromatique de 3 pieds.

"Note.—J'aperçois *Vénus* faisant une petite échancrure sur le bord du Soleil parfaitement terminé. Je ne crois pas que cette

Première phase s'écarte beaucoup de la véritable, parceque l'échancrure étoit très petite.

3 Juin 0 3 30 $\overset{h}{0} \overset{'}{5} \overset{''}{15} \overset{'''}{0}$

“Entrée du centre, estimée. Je fus très attentif à examiner si je verrois *Vénus* hors du Soleil, avec le croissant qui a été vu dans le passage de 1761 ; mais je ne l'apperçus pas. Je remarquai seulement que vers le milieu de l'entrée de cette planète on distinguoit une partie du disque de *Vénus* proche du disque du Soleil, tel qu'on le voit dans la figure première, planche troisième. Les deux corners, A et B, ou continuation du disque de *Vénus*; sembloient à la vérité annoncer le commencement du croissant que je n'aurai peut-être pas apperçu à cause que ma lunette grossissoit beaucoup et étoit par conséquent, moins claire.

Observé.	Temps Vrai.	
$\overset{h}{0} \overset{'}{15} \overset{''}{42}$	$\overset{h}{0} \overset{'}{17} \overset{''}{26} \overset{'''}{52} \frac{1}{2}$	Second contact.

“A l'entrée totale de *Vénus* j'observai très distinctement le second phénomène qui avoit été remarqué par la plus grande partie des astronomes en 1761. Le bord du disque de *Vénus* s'allongea (voy. figure 2). Comme s'il étoit attiré par le bord du Soleil. Je n'observai point pour l'instant de l'entrée totale,

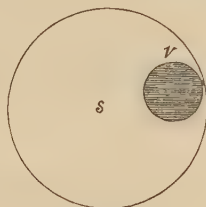


Fig. 2.

celui où le bord de *Vénus* commençoit à s'allonger ; mais ne pouvant pas douter que ce point noir ne fit partie du corps opaque de *Vénus*, j'observai le moment où il étoit à sa fin ; de façon que l'entrée totale ne peut être arrivée plutôt, mais peut-être plus tard de deux ou trois secondes. Le point noir étoit un peu moins obscur que le reste de *Vénus*. Je crois que c'est le même phénomène que celui que j'observai à Tobolsk en 1761.

Temps observé à la pendule.	Temps Vrai.
$\overset{h}{5} \overset{'}{53} \overset{''}{9}$	$\overset{h}{5} \overset{'}{54} \overset{''}{50} \overset{'''}{8} \frac{2}{3}$

Premier contact à la sortie, avec la lunette de dix pieds (not the same telescope). Le Soleil étoit ondoyant ainsi que *Vénus*, ce qui rendoit cette observation très difficile. A ce premier contact

Venus s'est allongée plus considérablement que le matin, en s'approchant tout-à-coup du bord du Soleil.

$$\begin{array}{ccc} \text{h} & \text{' } & \text{''} \\ 6 & 2 & 16 \end{array} \qquad \begin{array}{ccc} \text{h} & \text{' } & \text{''} \\ 6 & 3 & 57 \end{array} \begin{array}{c} \text{''} \\ 12\frac{1}{2} \end{array}$$

Sortie du centre estimée très exactement à ce qu'il m'a paru.

$$\begin{array}{ccc} \text{h} & \text{' } & \text{''} \\ 6 & 11 & 38 \end{array} \qquad \begin{array}{ccc} \text{h} & \text{' } & \text{''} \\ 6 & 13 & 19 \end{array} \begin{array}{c} \text{''} \\ 7\frac{1}{2} \end{array}$$

Second contact ou sortie totale. Elle ne me paroît pas être arrivée plutôt peut-être 4^s plus tard, mais je n'en suis pas certain.

"Pour observer avec toute la précision possible les deux contacts à la sortie, je disposai ma lunette de façon que je ne fusse pas obligé de la remuer vers ces moments. Sans cette précaution j'eusse été dans le cas de perdre de vue *Vénus*; de prendre le fond du ciel pour le bord du disque de cette planète, et de commettre ainsi une erreur énorme, au lieu qu'en ne quittant pas un instant de vue, au dernier contact, le bord de *Vénus* que paroissoit un peu plus noir que le fond du ciel, j'eus cette phase avec toute l'exactitude possible.

"J'avois chargé M. Pauly d'observer à la lunette de trois pieds les deux contacts de la sortie; il étoit déjà un peu exercé aux observations. Il observa le premier contact 22^s plutôt que moi et le dernier 37^s plutôt. Comme il étoit à côté de moi, je m'aperçus du moment où il quitta la lunette pour aller à la pendule et je vis très bien qu'il fixoit trop tôt les moments du premier et du second contact, car je voyois encore *Vénus* parfaitement lorsqu'il étoit à la pendule."

It is clear from Chappe's account that at the ingress he observed the breaking of the black drop. I have given the figure 2 for comparison with corresponding figures at Otaheite.

I consider, from the description given by Chappe himself, that at the egress he did not catch the formation of the black drop. He appears to have been surprised by the contact being established all at once. This view is materially strengthened by the observation of Pauly, who gives a contact 22^s earlier than that of Chappe. This observation of Pauly is clearly an observation of the formation of the black drop.

Observations made at King George's Island, in the South Sea, by Mr. Charles Green, formerly assistant at the Royal Observatory, Greenwich, and Lieut. James Cook, of H.M.S. *Endeavour*. *Phil. Trans.* 1771.

The telescopes employed in making the observations were, two reflecting telescopes of two feet focus each, made by the late Mr. James Short.

Transit of Venus by Mr. Green; magnifying power, 140.

	App. time.
	^h ^m ^s
First internal contact of ♀'s limb and the ☉, see fig. 4, (June 2)	21 43 15
Penumbra and ☉'s limb in contact, see fig. 5	21 43 55
First contact of penumbra. undulating, but the thread of light visible and invisible alternately (June 3)	3 14 3
Second internal contact of the bodies	3 14 51

Fig. 5.



Fig. 4.

Observations of Cook; magnifying power, 140.

First internal contact, or the limb of ♀ seemed to coincide with the ☉'s, fig. 2	21 43 15
A small thread of light seen below the penumbra, fig. 3	21 44 15
Second internal contact of the penumbra, or the thread of light wholly broken.. .. .	3 14 13
Second internal contact of the bodies, and appeared as in the first	3 14 45

Fig. 3.

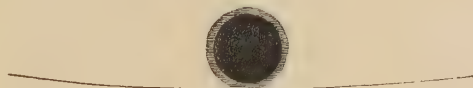


Fig. 2.

Dr. Solander's observations.

	^h ^m ^s
Ingress, light seen glimmering under ♀	21 43 28
♀'s free from the ☉'s limb	21 44 2
♀'s true limb out	3 31 49
♀'s atmosphere out	3 32 13

I shall not use Solander's observations. He has not observed the internal contact or breaking of black drop at egress: the time at ingress 21 44.2 falls between the two observations of Green and Cook, and its introduction would not therefore modify sensibly my result. There appears here a real difficulty in exactly understanding the phenomena observed by Green and Cook. I append Cook's remarks upon these observations.

"The first appearance of *Venus* on the Sun, was certainly only a penumbra, and the contact of the limbs did not happen till several seconds after, and then it appeared as in figure 4 (not given); this appearance was observed both by Mr. Green and me; but the time it happened was not noted by either of us: it appeared to be very difficult to judge precisely of the times that the internal contacts of the body of *Venus* happened, by reason of the darkness of the penumbra at the Sun's limb, it being there nearly, if not quite, as dark as the planet. At this time a faint light, much weaker than the rest of the penumbra, appeared to converge towards the point of contact, but did not quite reach it, see fig. 2. This was seen by myself and the two other observers, and was of great assistance to us in judging of the time of the internal contacts of the dark body of *Venus* with the Sun's limb. Fig. 5 (not given) is a representation of the appearance of *Venus* at the middle of the egress and ingress, for the very same phenomenon was observed at both: at the total ingress, the thread of light made its appearance with an uncertainty of several seconds; I judged that the penumbra was in contact with the Sun's limb 10'' sooner than the time set down above; in like manner at the egress the thread of light was not broke off or diminished at once, but gradually, with the same uncertainty: the time noted was when the thread of light was wholly broke by the penumbra."

It appears to me clear that the penumbra, *as dark or nearly as dark as the planet*, is nothing more nor less than a part of the planet itself. If this be so, Cook and Green have both observed contacts, and not the forming and breaking of the black drop. Cook states that at the egress he observed the time when the thread of light was wholly broken off by the penumbra.

I shall assume in my investigation that internal contacts were observed.

It now remains to form the equations of condition. $d\alpha$, $d\Delta$ denote the relative Tabular errors of *Venus* and the *Sun* in R.A. and N.P.D. $d\pi$ the correction required to the assumed value of solar parallax 8''.49, g , g' the corrections required by Encke's assumed semidiameter of *Venus* corresponding respectively to an internal contact and the formation or breaking of the black drop.

$$x = 6.57 d\alpha + 24.45 d\Delta + 39.71 g$$

$$y = 6.57 d\alpha + 24.45 d\Delta + 39.71 g'$$

Then $\frac{x-y}{2}$ = interval between the internal contact and breaking or forming of the black drop.

Wardhus.

The observations made use are of the internal contacts observed by Hell and Sajnovics.

Ingress.

Observer.

Hell $10^{\circ}237 d\alpha - 16^{\circ}236 d\Delta - 44^{\circ}50 d\pi - 19^{\circ}658 \varrho = - 34^{\circ}8$

Sajnovics $10^{\circ}237 d\alpha - 16^{\circ}236 d\Delta - 44^{\circ}50 d\pi - 19^{\circ}658 \varrho = - 35^{\circ}3$

Egress.

Observer.

Hell $16^{\circ}538 d\alpha + 8^{\circ}135 d\Delta + 30^{\circ}84 d\pi + 19^{\circ}658 \varrho = + 18^{\circ}6$

Sajnovics $16^{\circ}538 d\alpha + 8^{\circ}135 d\Delta + 30^{\circ}84 d\pi + 19^{\circ}658 \varrho = + 22^{\circ}6$

For the durations we have sensibly

(1) $x + 75^{\circ}34 d\pi = + 53^{\circ}4$

(2) $x + 75^{\circ}34 d\pi = + 57^{\circ}9$

Observer.

Hell.

Sajnovics.

Hell's observation at egress gives 12^s between the formation of the drop and internal contact.

Kola.

The observation here is from the breaking to the formation of the drop. The weight given to this equation will only be one half.

(3) $y + 76^{\circ}63 d\pi = + 21^{\circ}6$ Rumovsky.

Hudson's Bay.

The observations here are from the breaking to the formation of the black drop.

(4) $y + 23^{\circ}59 d\pi = + 0^{\circ}5$ Wales.

(5) $y + 23^{\circ}59 d\pi = - 0^{\circ}5$ Dymond.

St. Joseph.

The observations here are mixed.

Ingress.

Observer.

Chappe $10^{\circ}03 d\alpha - 16^{\circ}78 d\Delta - 2^{\circ}01 d\pi - 19^{\circ}941 \varrho^1 = + 3^{\circ}6$

V. Doz „ „ „ „ „ „ = + 1^{\circ}8

Medina „ „ „ „ „ „ = + 6^{\circ}8

Egress.

Observer.

Chappe $16^{\circ}64 d\alpha + 8^{\circ}78 d\Delta - 33^{\circ}31 d\pi + 19^{\circ}941 \varrho = - 2^{\circ}3$

V. Doz „ „ „ „ „ „ = - 5^{\circ}0

Medina „ „ „ „ „ „ = - 5^{\circ}0

For durations we have—

		Observer.
(6)	$\frac{x+y}{2} - 31'30'' d\pi = - 5'9$	Chappe.
(7)	$\frac{x+y}{2} - 31'30'' d\pi = - 6'8$	V. Doz.
(8)	$\frac{x+y}{2} - 31'30'' d\pi = - 11'8$	Medina.

Pauly at this station observed the formation of the black drop 22^s before Chappe observed the internal contact.

Otaheite.

The observations here are from internal contact to internal contact.

		Observer.
(9)	$x - 83'40'' d\pi = - 5'9$	Green.
(10)	$x - 83'40'' d\pi = - 15'9$	Cook.

Multiplying all the equations except the Kola equation by 2, and reducing the 10 equations by the method of least squares, I find the following equations for the determination of x , y , and $d\pi$.

$$\begin{aligned} 19x + 3y - 252'28'' d\pi &= + 309'0 \\ 3x + 12y + 48'10'' d\pi &= - 27'4 \\ - 252'28'' x + 48'10'' y + 123133'75'' d\pi &= 45536'46 \end{aligned}$$

$$\begin{aligned} \therefore 119113 d\pi &= 50220'58 \\ d\pi &= 0'''421 \\ \text{or } \pi &= 8'''91 \pm 0'008 \\ x &= 23'8 \\ y &= - 9'8 \\ \frac{x-y}{2} &= 16'6 \end{aligned}$$

ϵ is the probable error of a single observation of contact.

If $\epsilon = 3^s$ the probable error of π is $0'''02$.

The mean of the three results, 24^s, 22^s, 12^s, for the difference between the internal contact and breaking of the black drop is 19^s. The value of $\frac{x-y}{2}$ resulting from the equations of condition is therefore satisfactory.

It will be seen from the following table that the observed durations are all represented in a satisfactory manner.

I may here mention that the satisfactory solution of these equations in the way which has previously been virtually attempted by assuming $x = y$ is impossible. Of course by reject-

ing the observations at different stations, different results could be thus obtained, and any required value of the parallax within wide limits thus obtained.

The discordances between the computed and observed durations are reduced as follows,—

Observer.	^s		^s		Mean Error.
Hell	53'4	to	— 1'7	} Wardhus.	+ 0'6
Sajnovics	57'9	to	+ 2'8		
Wales	+ 0'5	to	+ 0'4	} Hudson's Bay	— 0'1
Dymond	— 0'5	to	— 0'6		
	+ 21'6	to	— 0'9	Kola.	— 0'9
Chappe	— 5'9	to	+ 0'5	} St. Joseph.	— 1'6
V. Doz	— 6'8	to	— 0'4		
Medina	— 11'8	to	— 5'4		
Green	— 5'9	to	+ 5'8	} Otaheite.	+ 0'8
Cook	— 15'9	to	— 4'2		

I consider therefore that, by simply interpreting strictly the language employed by the observers, I have been led to a solution which satisfies the whole of the ten observed durations, and gives at the same time, from the equations of condition, a satisfactory result for the difference between the time of internal contact and the breaking of the black drop. The value of deduced solar parallax $8''.91$ appears to me therefore entitled to great weight. It is in most satisfactory agreement with the values which have lately been otherwise obtained. I do not consider the incomplete observations of ingress, and particularly of egress, sufficiently numerous and well distributed to afford, by their combination with the observations here made use of, satisfactory determinations of $d \propto d \varphi \varphi'$, and to give, at the same time, a value of $d \Pi$ entitled to more, or even to equal confidence to that obtained from the durations. A great number of these observations were made under unfavourable circumstances, and the errors of observation as shown by their discordances are large. In addition to the mere errors of observation, we have, in the discussion of these imperfect observations, the full errors of assumed longitudes coming into the equations of conditions, and also errors of judgment in selecting the phase of the phenomenon of the transit of *Venus* really attempted to be caught by the observer.

I shall merely state, in conclusion, that I have not alluded to Powalky's discussion, because I consider that far too great license has been allowed the judgment in the selection of the materials to be used. Several of the results well represented in my equations are rejected as erroneous by him. If the necessity of separating the phenomena observed, in the way I have done, be admitted, no reliance can of course be placed upon any result

obtained without such separation. The data are, in fact, inconsistent, and nothing but confusion could result from the mere application of least squares.

Blackheath, 1868, Sept. 23.

On the Variability of η Argûs. By J. Tebbutt, Jun. Esq.

In the *R. A. S. Monthly Notices* for January 1866, was published a series of comparisons of η Argûs, made by me with neighbouring stars from 1854 to the middle of March 1865. A marked diminution of the star's light has taken place since that period, it being at present hardly distinguishable to the naked eye, even by oblique vision. I now forward a series of careful comparisons made since March 1865.

Comparisons.

1866, Feb. 16. Sky brilliantly clear. η Argûs was considerably less than B.A.C. 3655 or 3688.

1866, March 22. Sky very clear in the neighbourhood of η Argûs. Less than B.A.C. 3655 or 3688.

1866, June 29, 6^h 15^m P.M. Sky very clear, but η Argûs hardly distinguishable. Much less than B.A.C. 3655 or 3688.

1866, July 4, 6^h 45^m P.M. Sky beautifully clear, and the *Via Lactea* very distinct. η Argûs was much less than B.A.C. 3655 or 3688, and even less than B.A.C. 3642. It could be distinguished only by oblique vision; B.A.C. 3680 and 3673 could not be distinguished at all with the naked eye.

1866, Dec. 3, 10^h 20^m P.M. Scarcely distinguishable, and was very much less than B.A.C. 3655 or 3688.

1866, Dec. 8. Midnight. Sky beautifully clear, and the stars at a great altitude. η Argûs was very much less than B.A.C. 3655 or 3688. It was seen as a distinct stellar point in the nebula by oblique vision. It might be considered about equal, or perhaps superior, to B.A.C. 3642, the latter being seen by oblique vision.

All the foregoing comparisons were made with the naked eye.

1866, Dec. 11, 11^h P.M. By means of a small telescope, η Argûs was estimated to be brighter than B.A.C. 3673, and perhaps slightly inferior to B.A.C. 3642 or 3680.

The following comparisons, except those on May 4, 1867, and April 13 and 22, 1868, were made with a telescope of $3\frac{1}{4}$ inches aperture, and a magnifying power of about 30.

1866, Dec. 12, 11^h P.M. B.A.C. 3655, a light orange-coloured star, was considerably the brightest in the field of the telescope; it had a very small companion on the north side. B.A.C. 3642 and 3680 were the next in order of brightness, and

appeared to be about equal; B.A.C. 3648 next; then η Argûs, which about equal to B.A.C. 3657. B.A.C. 3673 was less than η Argûs. The magnitude of η Argûs by a very careful examination was intermediate between those of B.A.C. 3648 and 3673, and about equidistant between B.A.C. 3673 and 3680. The stars and nebula were beautifully distinct. There are no stars in the catalogued positions of B.A.C. 3679 and 3683.

1867, Jan. 12. Of η Argûs, B.A.C. 3655, 3680, and 3673, B.A.C. 3655 was much the brightest; η Argûs and 3680 were nearly equal; but 3680 decidedly the brighter, and 3673 the least of all. The comparisons were made between 9^h 30^m and 9^h 45^m P.M.; the stars being beautifully distinct; but the Moon about five days old in the west.

1867, Jan. 26, 8^h 20^m P.M. Beautifully clear night, and the Moon absent. Of the stars mentioned in the comparisons for Jan. 12, B.A.C. 3655 was the brightest, and η Argûs was greater than B.A.C. 3673 and less than B.A.C. 3680.

1867, March 2, 9^h 15^m P.M. Of the stars B.A.C. 3655, 3680, 3673, and η Argûs, the first was the brightest, η Argûs ranging between B.A.C. 3680 and 3673, but approximately to B.A.C. 3680. The night was beautifully clear, the Moon absent, and the stars at a great altitude.

1867, April 17, 6^h 40^m P.M. Clear sky, but Moon near the opposition. η Argûs was considerably brighter than B.A.C. 3673 and slightly inferior to B.A.C. 3680.

1867, May 4. B.A.C. 3680 less than B.A.C. 3655, and η Argûs less than B.A.C. 3680, and greater than B.A.C. 3673. The comparisons were made while the stars were crossing the field of the transit telescope.

1867, July 27, 9^h 25^m P.M. Beautifully clear sky, and the nebula about η Argûs very distinct. Of the stars B.A.C. 3655, 3680, η Argûs, and B.A.C. 3673, 3655 was the brightest; 3680 next; η Argûs next; and 3673 the least. The magnitude of η Argûs was nearer that of 3680 than that of 3673.

1867, Dec. 28. Sky beautifully clear. Of the compared stars, B.A.C. 3655 was by far the brightest; B.A.C. 3680 the next; η Argûs the next; and B.A.C. 3673 the least. The inferiority of η Argûs to B.A.C. 3680 was marked; but it was not much superior to B.A.C. 3673.

1867, Dec. 31. Of the compared stars, B.A.C. 3655 was the brightest, and η Argûs was certainly less than B.A.C. 3680, and somewhat greater than B.A.C. 3673. The comparisons were made about half an hour after midnight, the stars being at a great altitude.

1868, Feb. 26, 7^h 45^m P.M. Sky beautifully clear, and the Moon just set. Of the compared stars, B.A.C. 3655 was the brightest; η Argûs ranged between B.A.C. 3680 and 3673, but approximated to 3680.

1868, Feb. 27, 8^h 45^m P.M. Sky cloudless, and the nebula very distinct. η Argûs was compared with B.A.C. 3655, 3673,

and 3680. B. A. C. 3655 was the brightest of the four. η Argûs was greater than 3673, and less than 3680.

1868, April 13. B. A. C. 3642, 3655, 3673, 3680, and η Argûs were compared as they crossed the field of the transit telescope, both with and without illumination; the power employed being 25. The last four stars were compared at one view, B. A. C. 3642 having shortly before quitted the field. 3642 was not so bright as 3655. 3655 was much brighter than 3680. 3680 considerably brighter than η Argûs, and η Argûs slightly superior to 3673. The superiority of B. A. C. 3680 to η Argûs was very marked.

1868, April 22. The following comparisons were made in the field of the transit telescope, both with and without illumination. Of the compared stars, B. A. C. 3655 was by far the brightest. η Argûs was greater than B. A. C. 3673 and less than B. A. C. 3680. The inferiority of η Argûs to 3680, and its superiority to 3673, were marked.

It is obvious from these observations that η Argûs, during 1867 and the elapsed portion of the present year, has not exceeded the *sixth* magnitude. It does not appear, therefore, that the present variations of this star are reconcileable with the theory of Professor Wolf, in the *Monthly Notices* for May 1863, and the *Ast. Nach.* No. 1420, which gives 1861 and 3.6 respectively, as the time and magnitude for the minimum.

Windsor, New South Wales, April 29th, 1868.

Observations of a Minor Planet discovered by Prof. C.J. Watson at Ann Arbor Observatory, 1868, July 11.

	Ann Arbor M.T.			R.A.			Decl.		
	^h	^m	^s	^h	^m	^s	[°]	[']	["]
1868, July 11	13	36	14.7	21	10	54.40	—15	47	45.4
	15	16	47.9	21	10	52.28	—15	48	4.3
13	12	2	19.9	21	9	53.43	—15	57	24.9

The planet resembles a star of the 11th magnitude.

This planet appears to be the same as that independently discovered by M. Coggia on July 16.

E. J. S.

The Astronomische Gesellschaft.

Two biennial meetings have been held of the Astronomische Gesellschaft, the first at Leipzig, from August 31 to September 2, 1865, the second at Bonn, from August 22 to 24, 1867, both under the Presidency of Prof. Argelander. Among the subjects discussed at the meeting of 1867 are—

1. The Construction of New Tables of *Jupiter*. It appeared from communications received from MM. Hansen and Leverrier that both of these Astronomers were in fact occupied with the question, and thus that no action of the Society was requisite.

2. A new reduction of the older observations of the Periodic Comets had been in discussion at the Leipzig meeting. Four points had been specified—the new determination of the places of the stars of comparison, the calculation of the auxiliary quantities with the now-received values of the constants for the times of the appearance of the comets, the calculation of solar ephemerides for these times, lastly, the publication of the originals of the older comet observations.

As to the first point, Prof. Argelander had, in all the necessary cases, redetermined at the Bonn Observatory the places of the stars of comparison as collected by Prof. Schönfeld, and had published the new places in the sixth volume of the Bonn Observations.

As to the second point, it was hoped that the New Tables of Bessel's Auxiliary Quantities for the whole period 1750 to 1839, in continuation of the "*Tabulæ Pulcovenses*," beginning in 1840, would be published: this, however, was not undertaken by the Society, partly in consequence of it being known that some portions of the work had been accomplished or were in progress in America.

As to the third point, nothing has been done.

As to the fourth, some progress had been made by Prof. Argelander, who however mentioned that, for instance, the originals of the important observations of Triesnecker were not to be found, and that those of Olbers were not so perfect as to allow of a complete fresh reduction; it would be necessary in many cases to rest contented with the distances of comet and star as determined by Olbers himself.

Prof. Argelander remarked that he had been equally unsuccessful in discovering the original observations of Variable stars; those, for instance, of Pigott, Goodricke, and Koch, seemed to be quite lost.

It appeared that the calculations for the comets of Encke, Faye, Brorsen, D'Arrest, and Tuttle, were being proceeded with; but a list of thirty-one comets from 1830 to 1867 was given, which remained for further discussion. And a wish was expressed that Astronomers who were occupying themselves with any particular comets, or appearances thereof, would put themselves in communication with the Society.

M. von Struve expressed the like wish as to information being given to him at Pulkova in regard to any discussions of Double stars.

3. The need of a new reduction of Bradley's observations had been noticed as well at the foundation of the Society at Heidelberg, as at the Leipzig meeting. This however was not so much the concern of the Society as of the Pulkova Observatory, which

had received from Greenwich a carefully-compared copy of the Observation-Journals from 1750 to 1765, and of the other Bradley manuscripts; the work, in consequence of the illness of Dr. Winnecke, had been undertaken by Dr. Auwers.

4. A scheme by Prof. Schönfeld for the nomenclature of Variable stars was discussed.

5. A programme was received for the observation of all the stars up to the ninth magnitude between -2° and $+80^{\circ}$ declination. The co-operation of Astronomers was invited; the Observatories which had offered to take part in the work were Berlin, Bonn, Helsingfors, Leipzig, Mannheim, and (after the completion of some work in hand) Leyden.

6. A discussion took place, and some resolutions were adopted, as to the nomenclature of Comets and Minor Planets.

The next meeting was appointed to be at Vienna in the year 1869.

Besides the *Vierteljahrsschrift*, or Quarterly Journal of the Society, the following works have been published by them:—

I. Hülftafeln zur Berechnung specieller Störungen, enthaltend die rechtwinkligen Ecliptical-Coordinationen und die von Orte des gestörten Körpers unabhängigen Theile der Störenden Kräfte für die Planeten Venus, Erde, Mars, Jupiter, Saturn, Uranus, und Neptun, von 1830–1864. 1865.

II. Lesser, Dr. Otto. Tafeln der Metis mit Berücksichtigung der Störungen durch Jupiter und Saturn. 1865.

III. Weiler, Dr. A. Ueber das Problem der drei Körper im Allgemeinen und ins Besondere in seiner Anwendung auf die Theorie des Mondes.

IV. Hoüel, Dr. G. J. Tables pour la reduction du temps en parties décimales du jour. 1866.

V. Auwers, Arth. Reduction der Beobachtungen der Fundamental-Sterne am Passage-instrument der Sternwarte zu Palermo in den Jahren, 1803–1805, und Bestimmung der mittleren Recht-Ascensionen für 1805. 1866.

VI. Rechtwinkelige und Polar co-ordinaten des Jupiter (nach Bouvard's Tafeln) sowie Componenten der störenden Kräfte mit denen Jupiter auf die Sonne wirkt von 1770–1836. 1866.

VII. Anwers, Arth. Untersuchungen über veränderliche Eigenbewegungen. Zweiter Theil. Bestimmung der Elemente der Siriusbahn.

VIII. Schjellerup, genaherte Oerter der Fixsterne von welchen in den Astronomischen Nachrichten Band 1–66 selbstständige Beobachtungen angeführt sind, für die Epoche 1855 hergeleitet und nach den geraden Aufsteigungen geordnet. 1867.

Recent Publications.

Descriptive Astronomy, by George F. Chambers, F.R.A.S. Oxford, Clarendon Press, 1867, 8vo, pp. ix. to xxxvii. and 1 to 816.

The work appears to answer in a high degree to the author's idea of making it at once attractive to the general reader, serviceable to the student, and handy for the purposes of reference to the professional Astronomer. The arrangement of the subject is in the ten books:—The Sun and Planets, Eclipses and their Associated Phenomena, Physical and Miscellaneous Astronomical Phenomena, Comets, Chronological Astronomy, the Starry Heavens, Practical Astronomy, Sketch of the History of Astronomy, Meteoric Astronomy, and Astronomical Tables. Great pains appear to have been used in the collection and selection of the information, and in bringing it up to the latest period; and at the same time that the whole is in a very readable form, the facts are very frequently presented, as is obviously most convenient, in a tabular form: for instance, the history of particular discoveries or researches is given (often very completely) in the natural place in connexion with the celestial object to which they refer, but the short book of 21 pages, "Sketch of the History of Astronomy," is in fact a chronological table of Astronomers, occurrences, and discoveries. A valuable chapter on Celestial Photography and a Catalogue of Binary Stars are contributed to the work by Mr. A. Brothers. There are in all 224 illustrations; as to those of Clusters and Nebulæ, the author remarks that they are not at all to his satisfaction, there being the usual difficulty of preventing the undue exaggeration of the brilliancy of the stellar details.

Theoretical Astronomy, relating to the Motions of the Heavenly Bodies revolving around the Sun, in accordance with the Law of Universal Gravitation, embracing a Systematic derivation of the Formulæ for the Calculation of the Geocentric and Heliocentric places, for the determination of the Orbits of Planets and Comets, for the Correction of approximate elements, and for the computation of Special Perturbations; together with the theory of the combination of Observations and the method of Least Squares. By James C. Watson, Director of the Observatory at Ann Arbor, and Professor of Astronomy in the University of Michigan. London: Trübner and Co.

The somewhat long title of this remarkable and laborious work gives a general idea of its contents. The book commences with the fundamental principles of dynamics and treats systematically all the problems presented; the author hoping in this way

to aid the progress of the Science by attracting into the field and educating competent computers. Numerical examples are given, derived from actual observations and the tables which accompany the work are of great value.

M. Hoek has communicated to the Editor the following list of Errata in the paper on "The Phenomena of Meteors."

Page Line

132 10 W should be W_1 .

132 last line $\sqrt{A^2 + s}$, should be $\sqrt{A^2 + s^2}$.

133 3 $e = 0$ should be $e = 1$.

134 12 $x_2 = \mp \sqrt{A(1 + \cos B)}$, should be $x_2 = \mp \sqrt{\frac{1}{2}A(1 - \cos B)}$.

136 4 $\frac{p+x}{g}$ should be $\frac{p+x}{y}$.

136 7 $\frac{dy}{\sin \frac{1}{2}n}$ should be $\frac{dq}{\sin \frac{1}{2}n}$.

137 14 $R = 1$ should be $r = 1$.

138 table of values of D $27^\circ 7'$ should be 27.7 .

139 1 V should be U .

142 second form (40) $2 \cos \frac{1}{2} \cos H$ should be $2 \cos \frac{1}{2} n \cos H$.

142 20 $U = B_1$ should be $U = B$.

143 Table Sept. 4 should be Sept. 5.

143 last line 0.00879 should be 0.000879.

144 4 angular should be relative.

144 9 point R_1 should be point R .

148 20 observed s should be adopted s .

148 25 $\frac{g}{V_2} = 0.3809$ should be 0.4217 .

148 29 $31^\circ 15'$ should be $31^\circ 51'$.

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